2005
ANNUAL HABITAT WORK PLAN

PARKER RIVER NATIONAL WILDIFE REFUGE

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I. INTRODUCTION

Parker River National Wildlife Refuge was established in 1942 primarily to provide feeding, resting and nesting habitat for migratory birds. The Refuge consists of 4,662 acres of diverse upland and wetland habitats including, sandy beach and dune, Maritime shrubs and forests, interdunal swales brackish impoundments, salt marsh and associated creeks, mudflats, and salt panne. These Refuge habitats support varied and abundant populations of resident and migratory wildlife species including more than 300 species of birds and additional species of mammals, reptiles, amphibians, insects and plants. The Refuge also supports nesting piping plovers, a federally listed threatened species.

Parker River Refuge is currently developing a Habitat Management Plan, and expects a draft HMP by summer of 2006. The Refuge finalized a master plan in 1986; however, much of the wildlife goals and objectives from that planning effort are out of date. Current habitat management programs implemented on the Refuge are continuations of historic practices (impoundment and grassland management) or have been opportunistic (salt marsh restoration and invasive plant control).

II. HABITAT MANAGEMENT

A. Open Marsh and Water Management

Open marsh and water management (OMWM) has been ongoing at Parker River National Wildlife Refuge since 1991 through a partnership with the Northeast Massachusetts Mosquito Control and Wetland Management District (NEMMCWMD). In 2000, the Refuge signed up to participate in the Region 5 OMWM Study.

Habitat Objectives

The objectives of the OMWM program are:

- Return high water table and normal hydrology to marshes altered or damaged by grid-ditching, resulting in improved Service trust resource habitats and increased high marsh natural biodiversity.

- Provide satisfactory long-term biological control of saltmarsh mosquitoes in order to reduce or eliminate pesticide use on Service lands.

The objective of the OMWM Study is to determine how the various techniques are benefiting or impacting resources of concern (birds, vegetation, hydrology, fish, and mosquitoes).

In 2005, NEMMCWMD completed OMWM on 15 acres of salt marsh on the Refuge. To date, they've completed OMWM on approximately 100 acres of salt marsh habitat. Influence of the OMWM project extends beyond the actual acres completed.

Habitat Response
Vegetation and hydrology are being monitored as part of the ongoing regional study. The last portion of the study area was restored in October of this year. The data is analyzed annually by USGS Patuxent Wildlife Research Center and University of Rhode Island. Response of habitat will be analyzed at the end of the study in 2006.

Response of Resources of Concern
Macroinvertebrate use, bird use, and mosquito breeding data are being monitored as part of the ongoing regional study. The data is analyzed annually by USGS Patuxent Wildlife Research Center and University of Rhode Island. Response of habitat will be analyzed at the end of the study in 2006.

Proposal Year: Management Strategy Prescriptions
The last of the areas to be restored using OMWM techniques were completed in the fall of this year. Habitat and wildlife monitoring on the control and B2 sites will continue for another year. In the coming year, the data from the OMWM study will be analyzed to determine if OMWM practices are having the desired effects on the salt marsh.

B. Salt Marsh Bio-integrity Studies
Parker River participated in a salt marsh sparrow mercury bioaccumulation study in 2004. Preliminary results of high mercury concentrations prompted a long-term study by the Contaminants Branch of the New England Field Office.

Habitat Objectives
The objectives of the mercury bioaccumulation study are:

1. Create a profile of Hg exposure in salt marsh sparrows on four national wildlife refuges based on blood and egg Hg levels
2. Identify potential Hg pathways through a detailed GIS analysis of know point sources and modeled air deposition patterns
3. Determine if Hg levels are high enough to negatively impact salt marsh sparrow reproductive success.

In 2005, we captured and sampled blood Hg in 15 salt marsh sparrow adults and 3 unviable eggs. Concurrently, we put up 20 tree swallow nest boxes to sample swallow blood and egg Hg levels. Tree swallow have similar diets to salt marsh sparrow and past sampling have found a strong correlation between egg Hg levels of the two species. Hg blood samples were taken from 13 swallow adults and 21 swallow eggs.

The Refuge has been conducting salt marsh sparrow breeding surveys annually since 1999. The salt marsh sparrow survey was conducted on in late June/early July of 2005.

Habitat Response
Not applicable.

Response of Resources of Concern
Tree swallows responded immediately to the installation of the nesting boxes, occupying 10 of the 20 boxes. Nesting was initiated in three more boxes, but were abandoned prior to egg laying. At the end of the nesting season, five nesting pairs successfully fledged 20 chicks.

For the second year in a row, Parker River NWR had the highest mercury concentration in salt marsh sparrows of all sites samples in New England: 1.24 ppm compared to the mean of 0.839 ppm. In contrast, tree swallows at Parker River Refuge did not have significantly elevated levels of blood mercury (0.23 compared to a mean of 0.22 ppm). Additional analysis of egg Hg levels for both species will be completed upon securing additional funding.

Salt marsh sparrow data will be summarized pending completion of the US Geological Survey's web-based database to replace CENSUS.

Proposed Year: Management Strategy Prescriptions
The salt marsh sparrows at Parker River Refuge have been identified as having the highest concentration of blood Hg two years in a row. In 2006, we will proceed with the second phase of the study, which include a detailed GIS analysis of mercury loading for the Refuge, and additional sampling of salt marsh sparrows and their nests to determine impact on reproductive success.

We will continue the annual salt marsh sparrow breeding survey in 2006.

C. Grassland Management
Habitat Objectives
The Refuge has maintained 130 acres of grasslands through annual mowing to provide breeding and migratory habitat for grassland dependent species such as the Northern Bobolink, Savannah Sparrow, Meadowlarks and several species of raptors including Short-eared owls and Northern Harriers.

The grassland areas were historically mowed to provide goose browse, and have continued to be mowed every year. The open field habitat include: the North Pool Field, south portion of the Bill Forward Field, Cross-Farm Drumlin, Stage Island Drumlin, and Nelson's Island. The north portion of Bill Forward Field is maintained as early successional shrub habitat, and is mowed on a 3-5 year cycle. In 2005, we mowed the open fields in August and September.

Habitat Response
Although vegetation is not monitored in the grassland fields from year to year, staff has noticed increasingly woody and invasive vegetation in the fields. These include honeysuckle, glossy buckthorn, roses, bayberry, and black cherry.

Response of Resources of Concern
Grassland breeding bird surveys conducted at North Pool, Bill Forward, Cross Farm and Stage Island Fields from May 9 to June 27 found high populations of breeding bobolinks. Savannah sparrows were also consistently recorded during surveys. Although not strictly restricted to grasslands, red-wing blackbirds were also found in high numbers. One species not detected this year that had been reported as breeding in past years is the eastern Meadowlark.

Table 1a. Grassland nesting bird results for fix point surveys.

Fixed Point Survey	Max Count (Males Only)			Average Count		
	BOBO	RWBL	SAV	BOBO	RWBL	SAV
North Pool Field	11(9)	8(6)	3	9.4	3.6	1.6
Bill Forward Field	21(13)	4(3)	5	12.8	2	3.4
X-Farm 1	23(16)	1(1)	1	11.8	0.2	0.4
X-Farm 2	45(33)	6(4)	9	30.8	2.8	3
Stage Island 1	12(8)	10(10)	5	7.4	5	1.2
Stage Island 2	16(12)	3(3)	2	9.6	1.2	0.4
Total	**128(91)**	**32(27)**	**25**			

Table 1b. Grassland nesting bird results for walking route surveys.

Walking Survey	Max Count (Males Only)			Average Count		
	BOBO	RWBL	SAV	BOBO	RWBL	SAV
North Pool Field	23(16)	3(1)	3	17.5	1.75	1.5
Bill Forward Field	14(7)	9(9)	2	5.75	3.5	0.75
X-Farm 1	23(17)	2(0)	2	10	0.5	0.5
X-Farm 2	98(71)	6(4)	5	73.5	3.75	1.5
Stage Island 1	11(8)	4(2)	0	3.75	1.25	0
Stage Island 2	31(21)	6(2)	2	19.5	3.5	0.5
Total	**200(140)**	**30(18)**	**14**			

The grassland fields also provide habitat for American woodcocks, striped skunks, opossums, and wild turkeys; although no surveys are conducted for these species.

Proposal Year: Management Strategy Prescriptions
The North Pool Field will be completely mowed in late summer/early fall after ground nesting birds have fledged young. A few small areas that support cranberries will not be mowed in the lower elevations to provide berry picking opportunities for the visiting public. The Bill Forward, Stage Island and Nelson Island Fields will be mowed in late summer/early fall in a mosaic pattern, leaving small stands of milkweed and other wild flowers for butterfly use during fall migration. In 2006, the Refuge will continue the grassland bird surveys in order to establish baseline data.

Starting 2006, we will conduct a plant inventory of North Pool field, Stage Island Field, and Cross-farm field in order to assess the condition of the grassland, and determine future management.

D. Coastal Shrub and Maritime Forest Management

No active management is conducted for the Refuge's coastal shrub and maritime forest, except invasive plant control as described in Section E. However, several inventories are conducted annually to monitor wildlife use. These include the Region 5 standardized landbird breeding bird and anuran surveys. Landbird surveys were initiated in 1994, and are conducted once a year, usually in June. For 2005, the landbird survey was conducted on June 6th and 8th. The anuran survey consists of point counts at twelve different stations evenly distributed along the main road. For 2005, the anuran surveys were conducted three times, April 26th, June 2nd, and June 21st. Additionally, Massachusetts Audubon has been running a spring and fall migratory banding station in the shrub habitat on the Refuge since 1998.

The Refuge has an ongoing program to manage the white-tailed deer population on the Refuge in order to minimize impacts to the Maritime shrubs and forests. Deer population control is achieved through a one-day public hunt during the normal State hunting season. Starting in September, night spotlight surveys are conducted weekly to gauge population index from year to year.

Habitat Objective
The objectives of the wildlife surveys are to obtain baseline data for the various suites of wildlife species using the refuge's shrub and forest communities. The objectives of the deer management program are:

(1) Identify an index for determining the threshold population at which Refuge habitat can support white-tailed deer;
(2) Minimize deer browsing impacts the diversity and species compositions of the vegetative community; and
(3) Reduce over-deer browsing that negatively impacts function of scrub-shrub habitat as wildlife cover for Neotropical migrants;

Habitat Response
No habitat manipulation is conducted in shrub and forested habitat; therefore, no habitat response is measured.

Response of Resources of Concern
The deer population has been steadily declining since the implementation of the deer management program in 1995 (Figure 1). In 2005, we conducted 7 spotlight surveys and observed an average of 5.3 deer per night and a maximum count of 9 deer. Three females were taken during the one-day deer hunt.

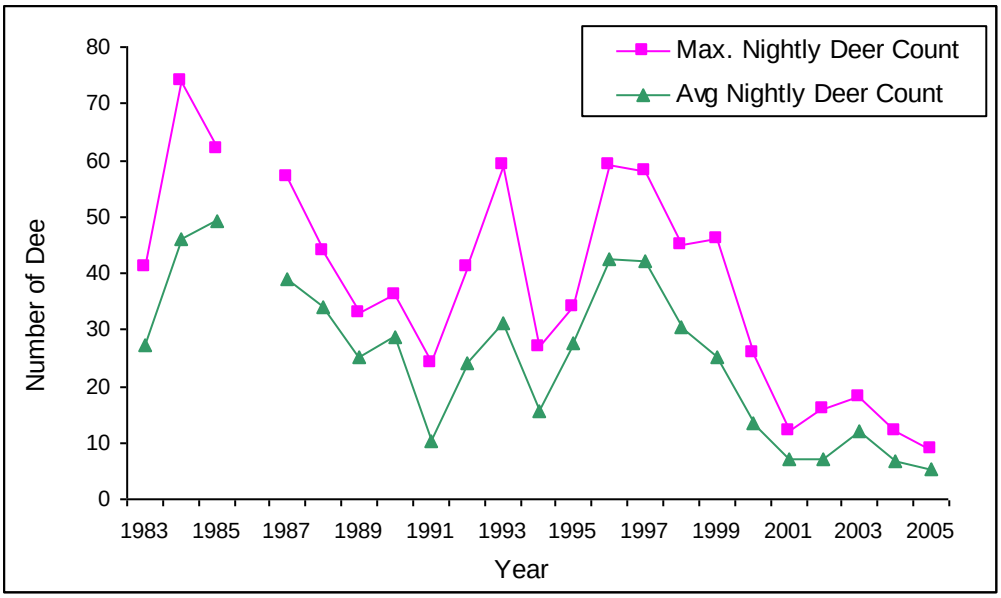


Figure 1. Summary of deer spotlight surveys from 1983 until 2005.

Breeding landbird surveys will be summarized pending completion of the US Geological Survey's web-based database to replace CENSUS.

Anuran Surveys

Relative abundance of spring peepers and American toads has increased from previous years (Figure 2), while species richness has decreased. Relative abundance is calculated from abundance values per station per species, where a value of '1' is calling frogs easily distinguished and counted; a value of '2' is overlap of calls between individuals, but individual can be counted, and a value of '3' is continuous full chorus. The State-listed eastern spadefoot toad, which was abundant in 2001 and 2004, was not detected in 2005. The absence of breeding spadefoot toads may be a factor of unfavorable environmental conditions or timing of surveys. Spadefoot toads are "explosive breeders". Great numbers of spadefoot toads migrate to vernal pools when conditions are ideal for breeding (drop in barometric pressure, heavy rain), often in a single night. Since we only survey four times during the breeding season, we may have missed the breeding window for the toads. Additionally, spadefoot toads may not have bred this year if environmental factors were not favorable.

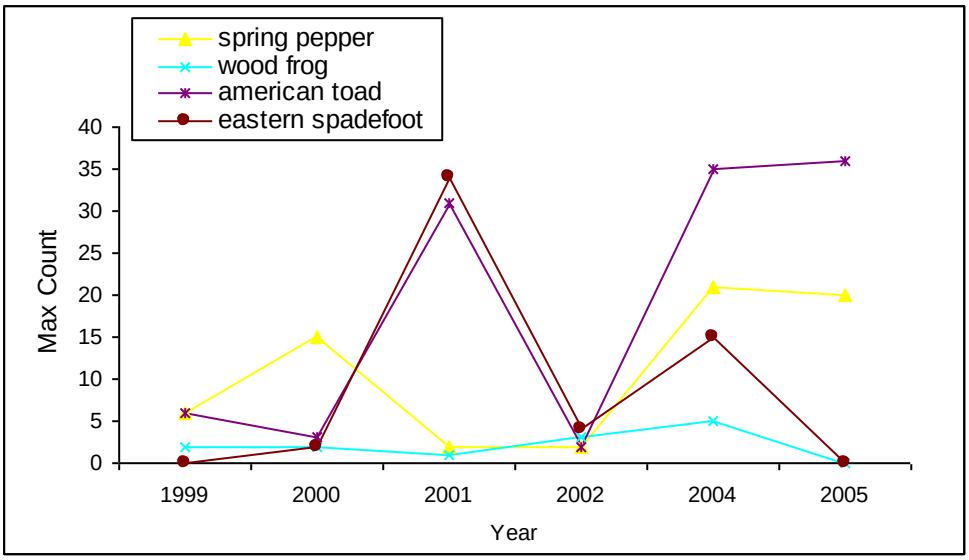


Figure 2. Maximum number of individuals detected during frog call surveys at Parker River Refuge from 1999 to 2005. From 2000-2002, four surveys were conducted during the breeding season (possible abundance values: 0 to 144). For the remaining years, only three surveys were conducted (possible abundance values: 0 to 108).

Migratory Landbird Banding

In 2005, the Massachusetts Audubon banding station banded 2,359 (860 birds in spring and 1,499 in fall) and 72 species (48 species in spring and 66 in fall) with a banding effort of 5,222 net hours (2,198 in spring and 3,024 in fall). The most common species captured were yellow-rumped warbler, gray catbird, and white-throated sparrow. Recapture data indicate that Parker River Refuge is an important stopover area for the migrating birds, particularly during the fall migration. This is especially true for young birds (hatched the same year), as they make up roughly 90 percent of all birds banded during the fall migration.

Table 2. Number and species of birds banded at the Massachusetts Audubon banding station at Parker River Refuge from 2000 to 2005.

Year	Spring			Fall			Total	
	# sp	# bird	catch per effort	#sp	# bird	catch per effort[1]	# sp	# bird
2005	48	930	42.31	66	1758	58.1	72	2359
2004	69	1361	51.00	66	2092	38.88	87	3453
2003	62	698	36 days*	45	881	39 days*	76	1579
2002	69	1473	63.8	57	1176	41.5	82	2649
2001	62	893	44.25	62	1484	59.67	76	2377
2000	59	695	44.80	52	1373	76.85	70	2068

[1] Catch per effort is calculated as the total number of birds caught per 100 net hours. For 2003, catch per effort was not calculated as survey effort was recorded in days instead of net hours

Proposal Year: Management Strategy Prescription
In 2006, we will initiate two new projects: restore Pitch Pine Dune habitats through removal of non-native pines (cutting, stump treatments) and planting of pitch pines, and search for presence of New England Cottontail.

We will continue to monitor anuran population through annual frog call surveys, and map potential breeding habitat within calling distance of each survey point. We will continue partnership with Massachusetts Audubon to collect data on migratory landbirds using the Refuge. Starting 2006, the deer surveys will be conducted every 3 years as the deer population has been relatively stable in the past decade. We will continue to host the one-day hunt to maintain the stable deer population.

E. Invasive Plant Species Management

Habitat Objectives
Invasive plant control has been implemented on the Refuge since the 1960's; however, efforts have mainly focused in the impoundments until recently. The Refuge recently completed a comprehensive map of all invasive plant species on Parker River Refuge. Twenty non-native species considered to be invasive[2] were found at Parker River occupying approximately 380 acre. Habitats most infested with invasive plants include the three Refuge impoundments, grassland habitats, and Maritime shrub habitats. In 2004, we launched several different control project targeting invasive plants based on the following criteria:

- Good likelihood of eradication
- Provide educational and outreach opportunities to the public
- Threaten plants, animals, and communities of management concern.

2005 Management Prescriptions
In 2005, we implemented the following control projects:

- Girdled and chemically treated (1.5-5%Garlon) ~20 acres of black locust
- Girdled and chemically treated (1.5 % Garlon) 0.1 acres of glossy buckthorn and honeysuckle.
- Aerially sprayed (4 pints of Rodeo per acre) 75 acres of Phragmites in the impoundments.
- Backpack sprayed (1% rodeo + 0.0075% escort) 20 infestions (0.2 ac) of Multiflora and beach rose.
- Treated (cut stem and drop with 20% rodeo) Phragmites in 9 interdunal swales and 3 stands in salt marsh habitat.
- Backpack sprayed (0.03% Escort) 40+ infestations (1.5 ac) of perennial pepperweed.
- Backpack sprayed (1.5 % Garlon) 0.6 acres and handpulled 5 stands of spotted knapweed
- Stem injected (50% Aquamaster) 10 stands (1 ac) of Japanese knotweed, all off-Refuge.

[2] As identified by the New England Invasive Plant Group.

- Managed against Phragmites in the impoundments using water level manipulation (see Section F for details)

Habitat Response

Habitat response to biological control of purple loosestrife has been very positive since the release of the beetles from 1996 to 2001. Four years after the last release of Galerucella beetles, the beetles are still present and reproducing at the release site. The abundance, vigor, and density of purple loosestrife have dramatically decreased since the start of the biological control program (Figure 3).

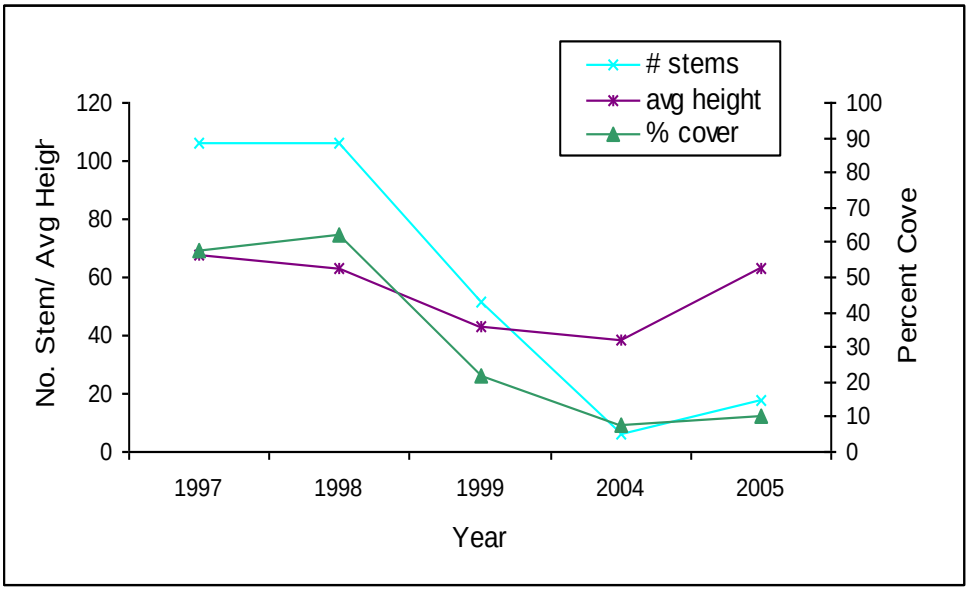


Figure 3. Percent cover, stem density, and average height of purple loosestrife since the release of *Galerucella* beetles (1996 to 2001).

Response of Resources of Concern

In 2004, we initiated several monitoring programs to evaluate success of the control projects. In 2005, we completed post-monitoring (second year) for black locust and perennial pepperweed control. Follow-up monitoring was not completed for Phragmites control due to staffing restraints. We also initiated monitoring to evaluate control of Japanese knotweed and multiflora and beach roses in 2005; the results of those monitoring will be available in 2006.

<u>Perennial Pepperweed</u>

In 2004, we compared two application rates of Escort (0.5 oz. per acre and 1.0 oz per acre) to Control (no treatment) using a randomized block design. Percent cover, stem density, plant height, and number of inflorences of perennial pepperweed and marsh elder (*Iva frustescens*) were monitored in one-meter vegetation plots. Post- monitoring was completed two week after application and in the following growing season.

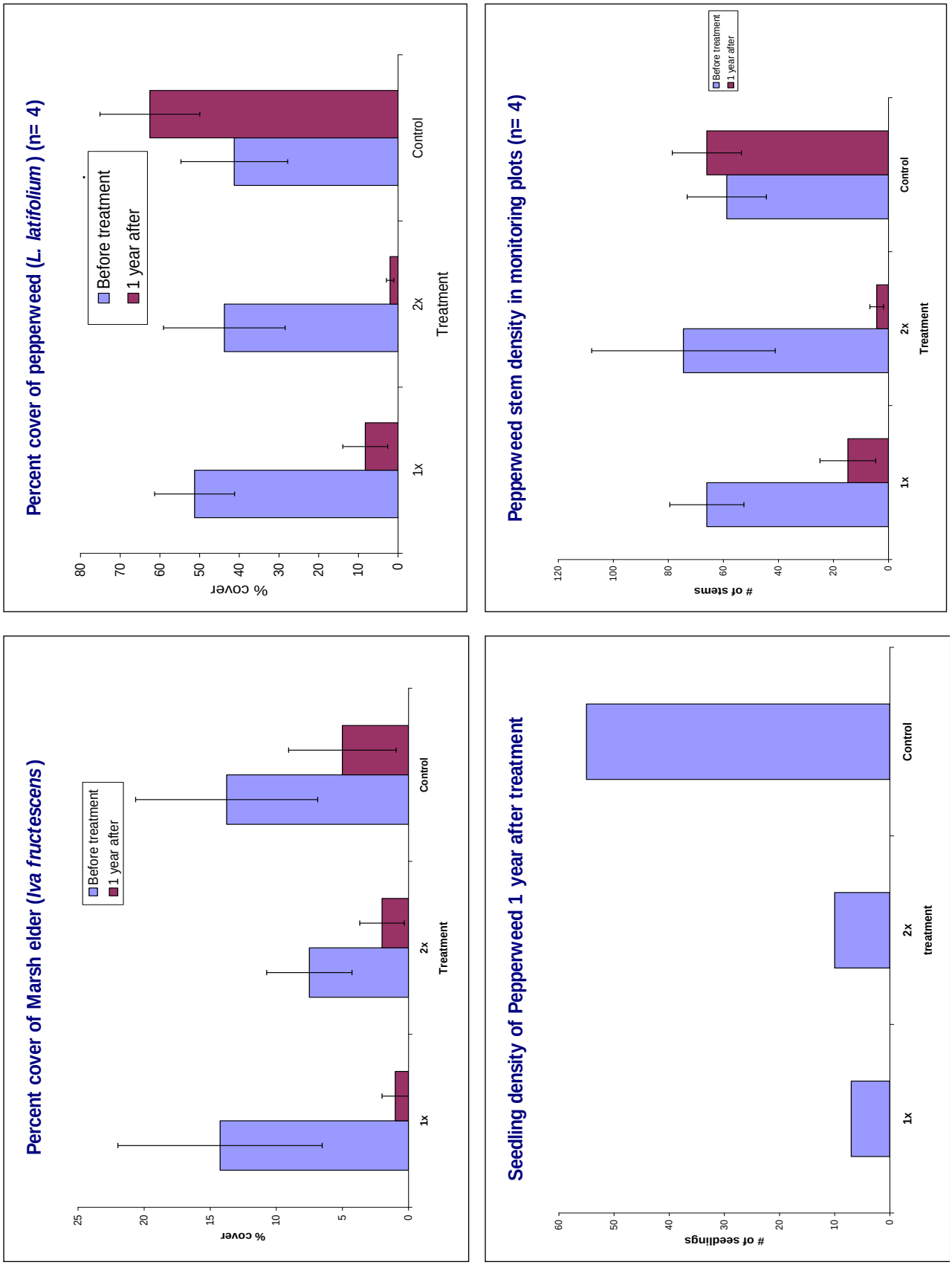


Figure 4. Response of perennial pepperweed and marsh elder to treatment with 0.5 and 1.0 oz per acre Escort compared against no control

Both treatments killed 100% pepperweed and marsh elder two weeks after application. In year 2, both treatments significantly ($p<0.05$) reduced the percent cover, stem density and average height of pepperweed (Figure 4a,b). Percent cover of pepperweed decreased by 85% and 96% while stem density decreased by 83% and 98% for 0.5 oz per acre and 1.0 oz per acre treatments, respectively. In the control plots, percent cover of pepperweed increased 131% while stem density increased 29%. In all treatment plots, perennial pepperweed went from dominating the plot to comprising less than 5% of the plots. Percent cover and stem density of marsh elder was lower in treatment than in control plots in Year 2, but not statistically significant (Figure 4c). No significant difference was found between the two treatments.

Data from our experimental study demonstrate that not only is Escort effective in killing perennial pepperweed (80-100%), but that there are multi-year effects of the herbicide. In all plots treated with Escort, graminoides dominates the plot where perennial pepperweed had the year before. Pepperweed seedling density was much higher in controlled vs. treated plots (Figure 4d), suggesting that pepperweed will continue to be controlled in coming years. While Escort also kills marsh elder, data indicates that the native shrub is being out-competed by pepperweed without treatment. We noticed that the treated plots had high number of marsh elder seedlings one year after treatment; suggesting that over time, marsh elder will re-colonize areas where pepperweed have been removed.

Black Locust

In 2004, the Refuge treated all locust trees within a 0.6-acre area, with a 1.5 percent solution of Garlon 4 (mixed with mineral oil). Three one-meter plots were established to monitor the vegetative response of black locust and other plant species. Treatment was 100% effective against black locust (2005 percent cover represent dead standing locust). Morrow's honeysuckle and forbes increased in abundance in response to the treatment (Figure 5). Two new species, yarrow and bayberry colonized the monitoring plots in 2005.

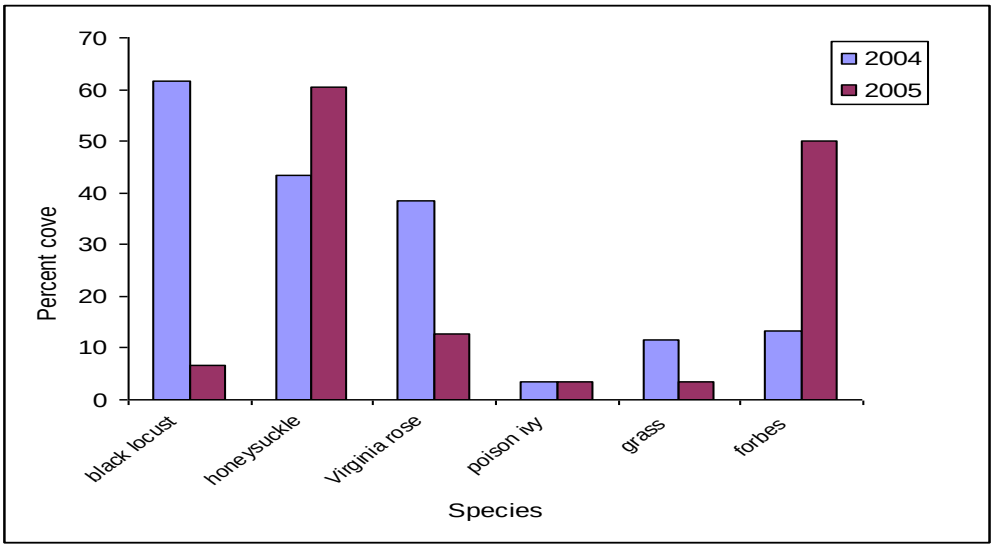


Figure 5. Percent cover of plant species before and after black locust control (girdle and application with 3% Rodeo).

Autumn Olive

In 2004, we bulldozed 12 autumn olive trees along the main road. Although formal monitoring was not conducted, follow-up inspections found no resprouting of autumn olive seedlings at the control sites.

Proposal Year: Management Strategy Prescriptions

- Complete second year monitoring of Rose and knotweed control. Complete third year monitoring of pepperweed control plots. Follow-up on control of Phragmites in the swales.

- Coordinate with partners in the Great Marsh to control Phragmites, Japanese knotweed and perennial pepperweed adjacent to the Refuge to prevent re-invasions;

- Map occurrences of native pitch pine (*Pinus rigida*) and non-native red pine (*Pinus resinosa*) and black pine (*Pinus nigra*). Develop partnership with Minuteman Regional High School to grow and plant pitch pine saplings to replace non-native pines.

- Continue to treat all perennial pepperweed detected on the Refuge. Expand biological control of purple loosestrife to include the new headquarters' site. If time and funding allows, expand treatment of black locust, spotted knapweed, Morrow's honeysuckle, and multiflora rose.

F. Impoundment Management

Background

Parker River's three man-made impoundments were constructed in the 1950s, and have historically been managed for breeding waterfowl. The North Pool total 129 acres, and is largely dominated by invasive Phragmites. A water control structure connects the impoundment with Plum Island Sound; however, the structure is undersized, and we're not able to obtain sufficient flow to effectively manage the impoundment.

The Bill Forward Pool total 34 acres, and is separated from the North Pool by a cross dike. There is a water control structure connecting the impoundment to Plum Island Sounds; however, it is undersized and installed too high for water management. The Refuge uses a high capacity water pump to lower the water level within this impoundment. This impoundment has the greatest management capability due to its gradual sloping elevations. Most years, we're able to manage the impoundment for both spring and fall shorebird migrations as well as for waterfowl migration.

The Stage Island Pool (SIP) is located about 5 miles south of the NP & BFP and totals 118 acres. Approximately 53 acres of the impoundment can be managed as a moist soil unit due to its gradual sloping pool bottom elevations; the remainder of the impoundment is dominated with robust vegetation. Water level manipulation is conducted using a

water control structure connected to a tidal estuary. When flooding with tidal water, we try to maintain the water salinity below 20ppt.

Habitat Objectives
Management of the three impoundments requires an adaptive and integrated approach to water level management. The objectives of impoundment management are:
1: provide exposed mud flats and shallow water foraging areas for spring and/or fall migrating shorebirds
2: provide shallow water foraging areas and seed bearing moist-soil plant species for fall migrating waterfowl
3: provide habitat for marsh and wading birds by maintaining high water levels during the breeding season (spring early summer)

Challenges to successful management of the three impoundments include (1) lack of a freshwater source; (2) dominance of invasive plant species, particularly Phragmites (3) an inability to adequately flood and drain some or all of the impoundments. Due to these management challenges, only a portion of each impoundment can be effectively manageable to meet the above objectives.

Since 2002, Refuge staff has managed the Bill Forward and Stage Island Pools to control invasive and robust vegetation in order in increase plant diversity and shorebird and waterfowl habitats. Management strategy included chemical spray and mowing robust vegetation (Phragmites and cattail) in the fall, and flooding the impoundment through the following growing season to discourage growth. To provide habitat for spring migrating shorebirds, we alternate spring draw down of the impoundments from year to year . The table below summarizes management practices in the two impoundments from 2002 to 2005.

Table 3. Summary of management practices in the Bill Forward and Stage Island Pools from 2002 to 2005.

Year	Bill Forward Pool	Stage Island Pool
2002	Draw down in May; Mowed in Oct, Reflood for winter	Draw down in April; Mowed in October, Reflood for winter
2003	Draw down in April; Attempted discing (~1 ac completed before equipment failure); Reflood for winter	Draw down in July; Reflood for winter
2004	Draw down in July; Mowed in October; Disced 3-5 acres of Phrag; Reflood for winter	Draw down in April; Mowed in October, Reflood for winter
2005	Draw down in July, sprayed Phragmites in Sept.; no mowing; Reflood for winter	Draw down in April, Sprayed Phragmites in Aug.; mowed in Oct/Nov; Reflood for winter

In 2005, Parker River Refuge participated in the Region 3/5 Impoundment Shorebird Study. The objective of this three year study is to determine how the timing of water manipulation affects use of the impoundments by waterbirds, particularly shorebirds,

waterfowl, and wading birds. The study will also investigate the capabilities of each refuge to contribute to regional goals for each guild of species, and response of the vegetative community to various management actions. As part of the study, we established absolute elevations to known points at each impoundment, and installed new water level gauges set to absolute elevations in the Bill Forward and Stage Island Pools.

Management Prescription in 2005

North Pool

In 2004, the refuge completed a four-year study to determine feasibility of restoring this impoundment back to a self-sustaining tidal marsh. The result of the study indicates a high probability of a successful restoration. The restoration of the impoundment was deferred due to opposition from the birding community, who wants the impoundment managed to benefit marsh and wading birds. Alternatives to the future management of the North Pool are being fully explored in the Refuge's ongoing HMP. In 2006, we maintain high water level in the impoundment and conducted breeding marsh and wading bird surveys.

Bill Forward Pool

This is one of two impoundments that participated in the R3/5 Impoundment Study. The Bill Forward Pool was randomly selected for a fall draw down. The objective was to expose the maximum mud flat and shallow water (< 10 inches) during peak fall shorebird migration (August 10). We started the draw down of the Bill Forward Pool on July 8, and continued until August 17. The water level was drawn down from 3.28' to just below 1.8' (lowest elevation on water gauge) during this period (Figure 6a). Flood-up of the impoundment occurred naturally through rainfall. In early August, we aerially sprayed Phragmites stands with Rodeo (4 pints per acre) to control robust vegetation. Phragmites stands were mapped using GPS and uploaded to the spraying equipment in the helicopter to ensure targeted spraying.

Stage Island Pool

Stage Island Pool was randomly assigned to undergo spring drawdown under the Regional3/5 Shorebird Study. The objective was to expose maximum mudflat and shallow water during peak spring shorebird migration (May 25). We started draw down in Stage Island on April 20th, and continued until July 14. During this period, the water level in the impoundment was drawn down from 5.38' to 0.5' (Figure 6b). Flood up of the impoundment started on Sept 23rd, but was suspended from October 24 to November 16 so that mowing of robust vegetation can be completed. Flood up continued on November 29, and continued until freeze up on December 6th. To control robust vegetation, we aerial sprayed the Phragmites in the impoundment with Rodeo (4 pints per acre) in August, and mowed standing phragmites in late October/early November.

Habitat surveys conducted as part of the impoundment study include two vegetation cover surveys and a species composition survey. For continuity of data, we also conducted vegetation surveys per 1994 protocol. Additionally, water levels and salinity are monitored in the impoundment throughout the growing season. Water salinity was

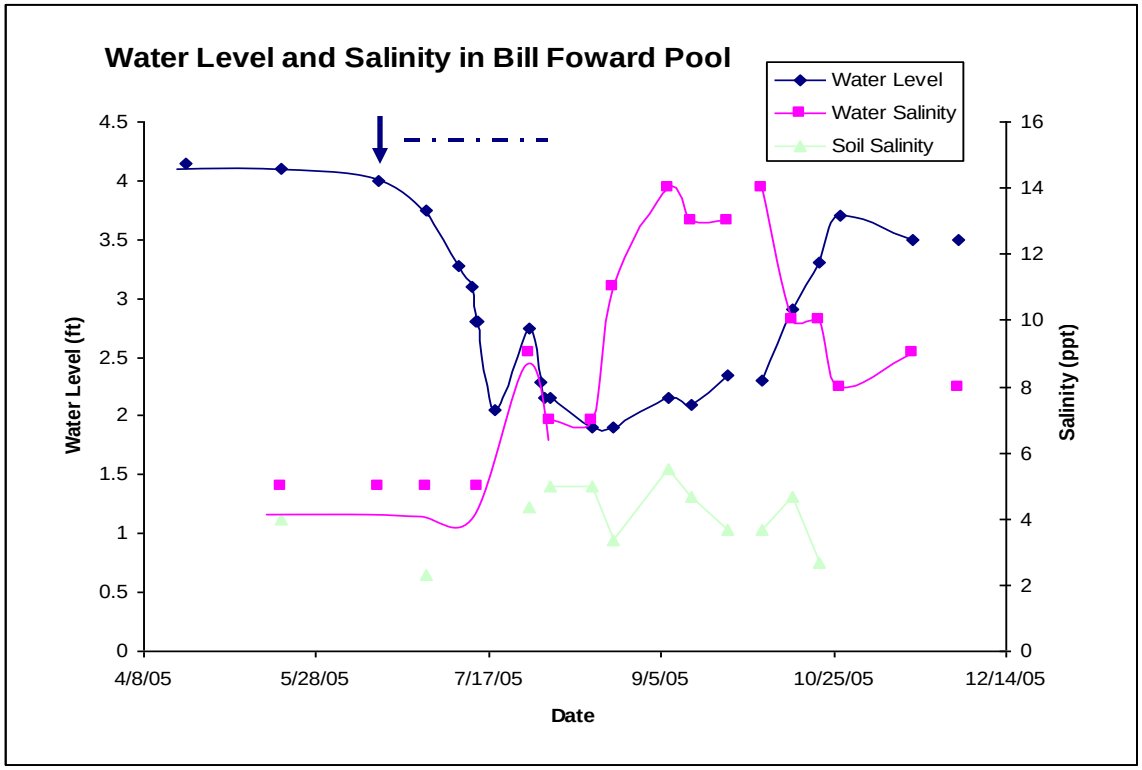


Figure 6a. Water level and salinity in the Bill Forward Pool for 2005. The arrow and dashed line indicate period of active draw down.

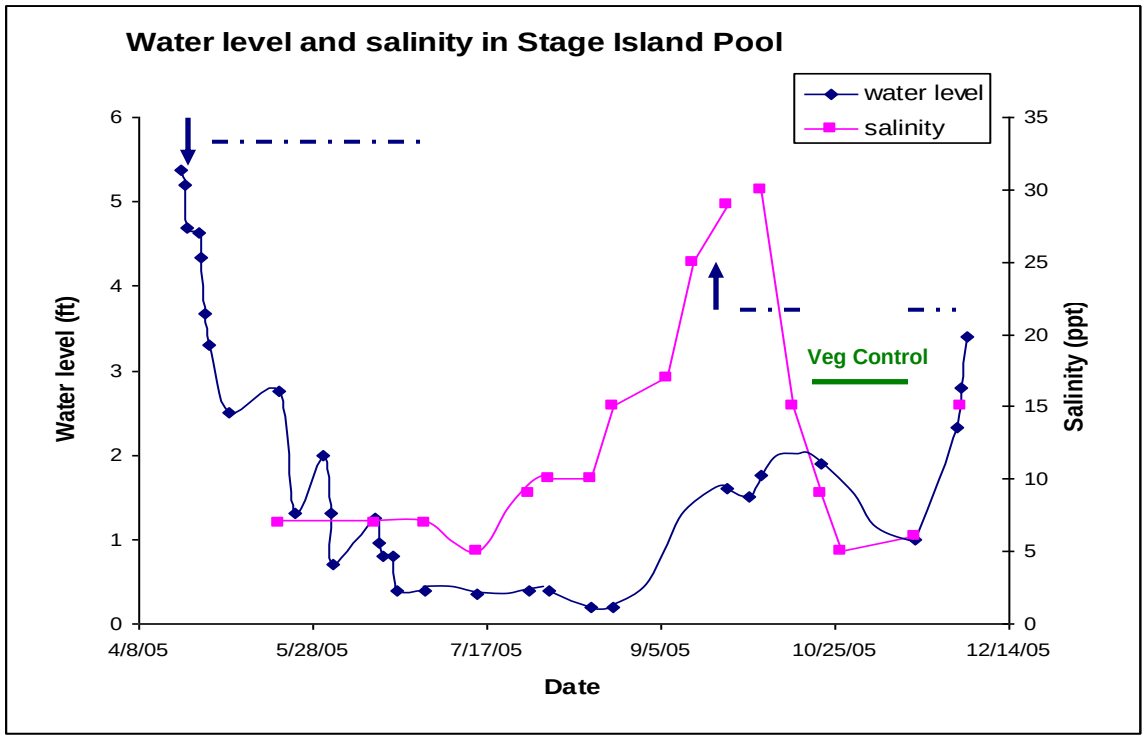


Figure 6b. Water level and salinity in the Stage Island Pool for 2005. The arrow and dashed line indicate period of active draw down and flood-up. Flood-up was suspended for three week (October 24 to November 15) so that we can mow robust vegetation in the impoundment.

monitored at the water control structure. To assess whether brackish water management affected vegetation, we monitored soil salinity at three locations within each impoundment (see Map 1). Wildlife surveys conducted as part of the impoundment study includes weekly waterbird surveys and two invertebrate surveys, timed with peak spring and fall shorebird migrations. Additionally, monthly bird surveys conducted by volunteers since the early 1990s were continued in all three impoundments.

Habitat Response

Water salinity in BFP peaked at 14 ppt in early September, when water was lowest from draw-down and evaporation. Average soil salinity in BFP ranged from 2 to 6 ppt (Figure 6b). Water salinity in the SIP peaked at 30 ppts in mid October (Figure 6a). The higher salinity can be attributed to brackish water management (flooding with brackish water) and evaporation during the summer months. Results of the soil salinity monitoring found that flooding of the impoundment with brackish water is not affecting soil salinity in SIP (range 0-4 ppt). Consequently, the current brackish water management is not altering the vegetative community in the impoundment.

Appendix A includes the complete list of plants found in the impoundments from 2003-2005. The most common plants found in Bill Forward Pool in 2005 include *Agrostis stolonifera* (30%), *Eleocharis parvula* (29%), *Phragmites australis* (11%), *Lythrum salicaria* (6%) and *Typha latifolia* (6%). These same plants were the most abundant species in the 2004 survey.

Because of the diverse habitat in SIP, the vegetation data is stratified into two habitats: moist soil and robust vegetation area. The most abundant plants found in the Stage Island Moist Soil area include *Typha latifolia* (18%), *Panicum dichotoflorum* (11%), *Eleocharis parvula* (10%), *Cyperus filicinus* (7%) and *Spartina pectinata* (3%). Bare ground (36%) and water (10%) also were abundant in the moist soil area. In the Robust vegetation area, the most abundant plants include *Panicum dichotolorum* (34%), *Phragmites australis* (30%), *Typha latifolia* (9%), *Panicum sp.** (6%), and *Agrostis stolonifera* (5%). There were also a lot of bare ground in the robust area (Freq= 0.33; Abun=16%), suggesting that the management practices summarized in Table 3 is successfully managing robust vegetation. *Lythrum salicaria* is a relatively common plant (high frequency of occurrence) in both impoundments, but is not dominating the vegetative community. The Galerucella beetles released in the impoundment from 1996-2001 is continuing to control this invasive plant.

Phragmites in the Bill Forward Pool increased from 2002 to 2005, then decreased by nearly 50 percent from 2004 to 2005 (Figure 7a). Phragmites in the Stage Island pool has steadily decreased from 2002 to 2005 in the Moist Soil Area (Figure 8d), while it dropped dramatically from 2002 to 2003, have remained stable or increased from 2003 to 2005 in the Robust Vegetation Area (figure 8b). Decreases of Phragmites in both impoundments are strongly correlated with mowing in the fall, followed by flooding the vegetation during the early part of the growing season (until July).

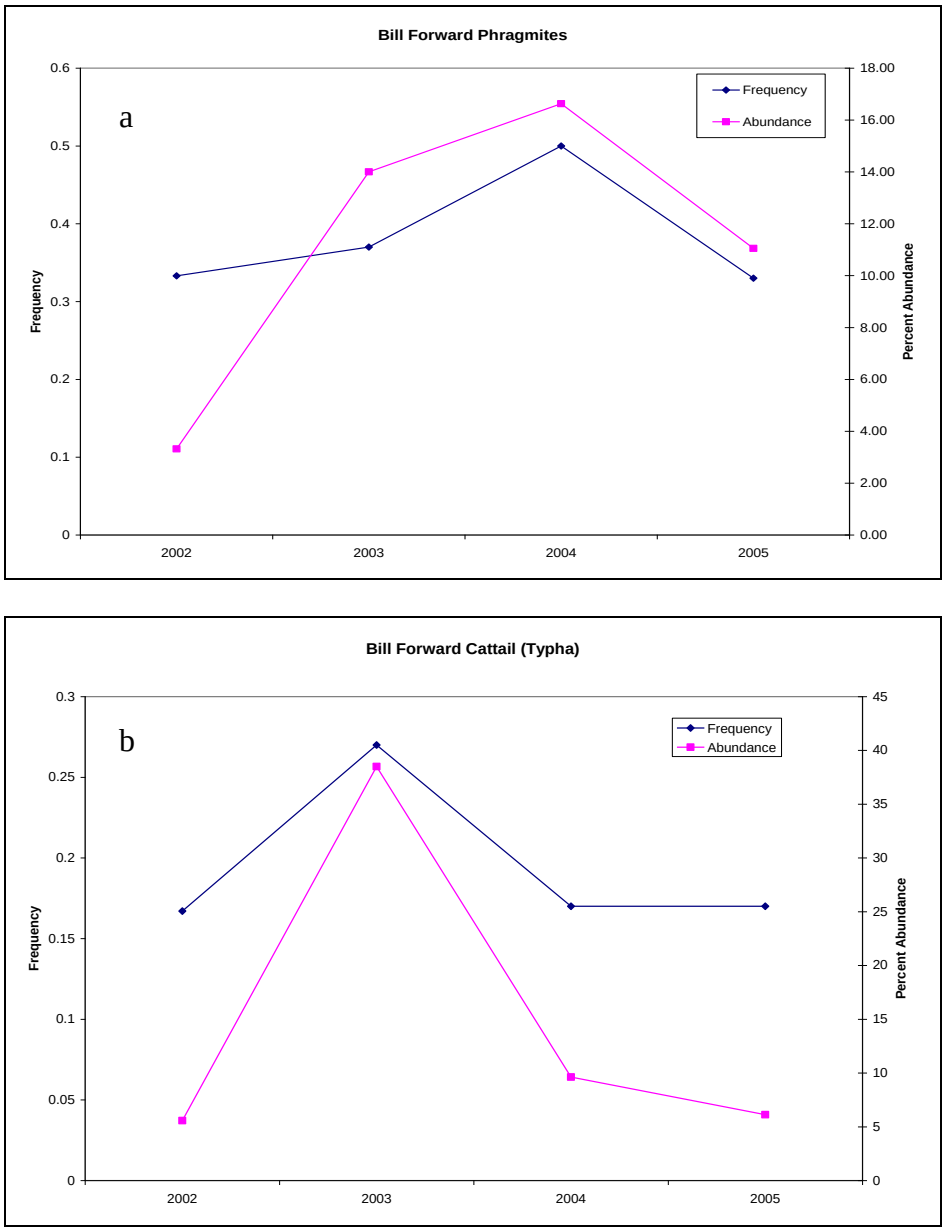
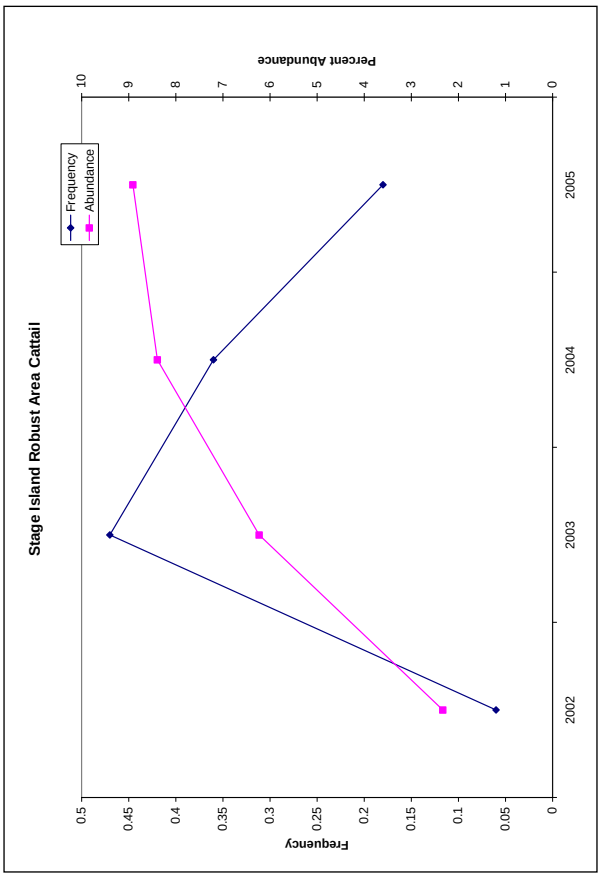
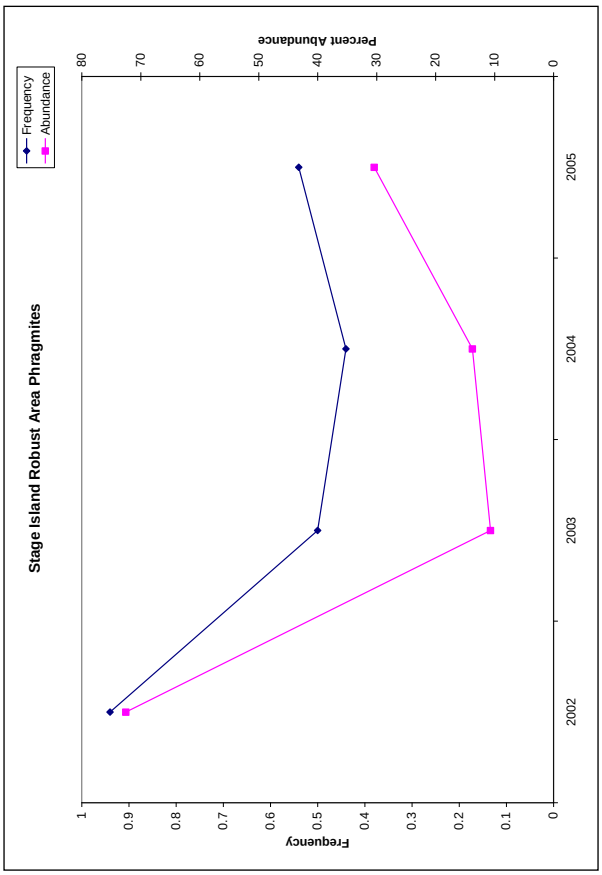
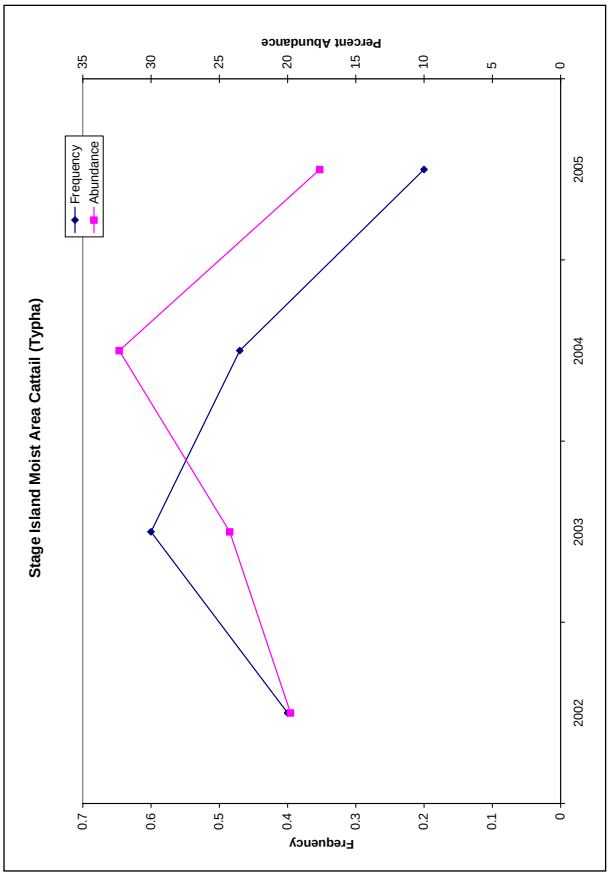


Figure 7. Frequency occurrence and percent abundance of Phragmites and cattail in the Bill Forward Pool from 2002 to 2005.







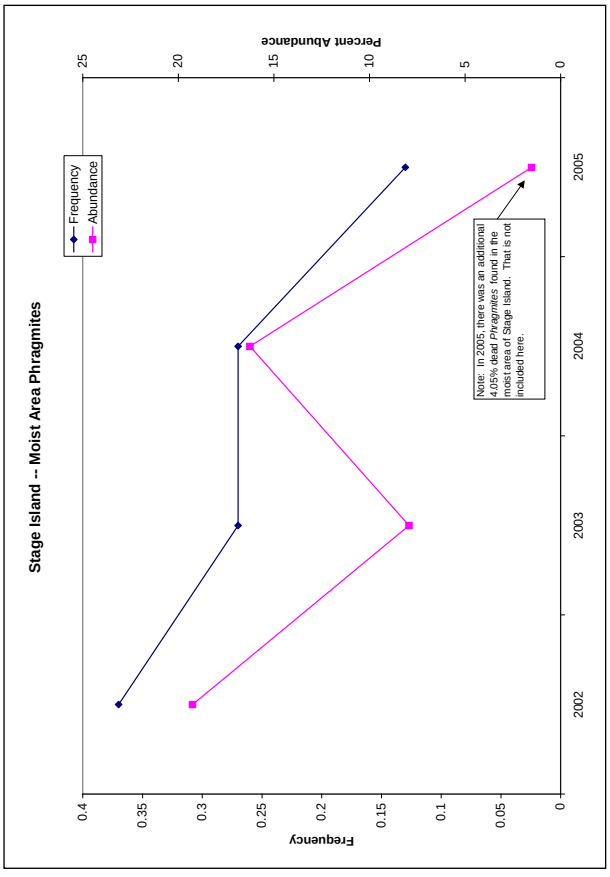


Figure 8. Frequency of occurrence and percent cover of Phragmites and cattail in Stage Island Pool

Cattail exhibited mixed responses to the management regime, with the species increasing in abundance in the Stage Island Robust Vegetation Area (Figure 8a), decreasing in the Moist Soil Area (Figure 8c), and no detectable trends in the Bill Forward Pool (Figure 7b).

In 2004, we disced a small section of the Phragmites stands in the BFP after mowing. Results of second year vegetation monitoring found reduced species richness and overall percent cover. However, three moist-soil vegetation species, dwarf spiked rush (*Eleocharis parvula*), Olney's bulrush (*Scirpus americanus*), and salt marsh bulrush (*Scirpus robustus*) increased their abundance from 2004 to 2005. Our data suggest that mowing and discing further reduced percent cover of Phragmites, cattail, loosestrife compared to mowing alone (Figure 9). In the short-term, mowing, discing, and flooding for part of the growing season seems to benefit waterfowl species.

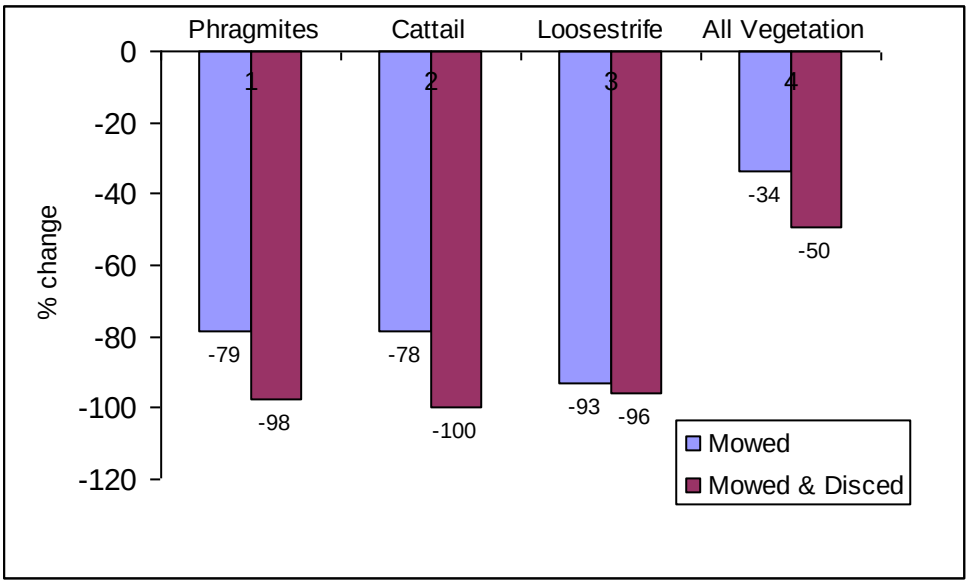


Figure 9. Percent change (2004 to 2005) in percent cover of Phragmites, cattail, loosestrife, and other vegetation in mowed vs. mowed and disced plots in the Bill Forward Pool.

Response of Resources of Concern

Peak waterbird use in both impoundments occurred during the fall shorebird migration (Figure 11). Maximum bird use in Stage Island Pool, with 1,341 birds, was recorded on August 8. Maximum bird use in Bill Forward Pool, with 1,233 birds, was recorded on August 17. Shorebirds were by far the most numerous guild using the impoundments.

Peak shorebird use in the two impoundments corresponded with the anticipated three migration peaks: spring, fall adult, and fall juvenile. Peak spring migration occurred on June 7 (382, dominated by SESA) in SIP. Shorebird did not use BFP during the spring migration as there was no available habitat during that period (flooded). Peak fall adult migration occurred on July 25 (582) in the BFP and on July 18 (701) in the SIP, both dominated by SESA and SBDO. Peak fall juvenile migration occurred on August 8 (1,230) in the SIP and August 17 (1,151) in the BFP, both dominated by SESA, SBDO, SEPL, and LESA (Figure 12).

Figure 10. Waterbird use in Bill Forward and Stage Island Pool throughout 2005 growing season.

Figure 11. Shorebird use in Bill Forward and Stage Island Pool throughout 2005 growing season.

Figure 12. Waterfowl use in Bill Forward and Stage Island Pool throughout 2005 growing season.

Figure 13. Wading bird use in Bill Forward and Stage Island Pool throughout 2005 growing season.

Total invertebrate availability and abundance was higher in the SIP during spring shorebird migration and higher in the BFP during the fall shorebird migration (Table 5). Accordingly, shorebird density was higher in the Bill Forward Pool (24.25/ acre for adult migration and 47.96/acre for juvenile migration) than the Stage Island Pool (13.23/acre for adult migration and 23.2/acre for juvenile migration) during the fall. The relative abundance of invertebrates and shorebirds is consistent with anticipated use given the drawdown schedule.

Table 5. Invertebrate abundance in the Bill Forward and Stage Island Pool during spring and fall peak migration. Sampling during spring migration was conducted from May 16 to 19. Sampling during fall migration was conducted from August 1 to 4.

	Water Column Inverts			Benthic Inverts			
Sample ID	# Pts	# Invert	Total Mass (mg)	# Pts	# Invert	Total Mass (mg)	Density (# per sq. cm)
BFP, Spring	32	9	1.25	4	23	15.25	0.07
SIP, Spring	14	109	4.91	29	454	115.58	0.20
BFP, Fall	27	62	14.33	23	1239	209.0	0.69
SIP, Fall	4	0	0	32	293	92.5	0.12

Waterfowl was the second most numerous guild using the impoundments. Peak waterfowl use was recorded in Bill Forward Pool on October 18 (628 dominated by GWTE, NOPI, CAGO), and on December 1 in the Stage Island Pool (744 dominated by GWTE, NOPI, CAGO, MALL) (Figure 13). The delay in peak use in Stage Island Pool is probably due to the delayed flooding of the impoundment in order to accommodate scheduled mowing.

Wading birds use in Bill Forward Pool was significantly higher than that in Stage Island Pool (Figure 14). Wading bird use peaked on July 25 (52, mainly SNEG) and again on September 12 (25, mainly SNEG and GREG). Breeding marsh and wading bird surveys were conducted four times in the North Pool. A total of six marsh and wading bird species were detected during the surveys, the most common species were sora and Virginia rails.

Table 6. Results of marsh and wading birds call-back surveys in the North Pool.

	13-May	1-Jun	19-Jun	12-Jul
Sora Rail	8	4	5	3
Virginia Rail	6	5	4	2
Least Bittern	4	1	0	0
American Bittern	0	1	0	0
Common Moorhen	0	2	2	0
King Rail	0	0	2	0

Proposal Year: Management Strategy Prescriptions

In 2006, we will continue to collect marsh and wading bird breeding data in the North Pool while maintaining high water levels. Management prescription for the Bill Forward and Stage Island Pool will be flipped per study design so that BFP will be drawn down in April and SIP drawn down in July. Completion of bathymetry maps for the

impoundment will allow us to fine tune the water level management to maximum waterbird use.

All habitat and wildlife surveys will continue. Robust vegetation management in the form of chemical application and mowing will be implemented if staffing and budget availability allows. We will follow up with second year monitoring of vegetative response to mowing and dicsing in the Bill Forward Pool to obtain long term habitat response data. Both impoundments will the reflooded prior to freeze up. The water control structure at Bill Forward Pool will be replaced in 2006 through a partnership with Ducks Unlimited.

G. Beach (Plover and Tern) Management

Habitat Objectives
Protect 6.4 miles of piping plover habitat on the Refuge beach by restricting public access to nesting areas beginning April 1 and continuing until all plovers have fledged. Survey and record productivity 4-5 times per week. Symbolically fence and sign known nesting sites on Sandy Point State Reservation and on the Town managed beaches in Newbury and Newburyport. Survey areas 3-4 times per week.

Protect nests from predators through the use of exclosures and implement control on nuisance animals. Follow the guidelines as described in the Atlantic Coast recovery plan which targets a productivity of 1.25 young per breeding pair.

2005 Management Prescription
6.2 miles of Refuge beach were completely closed to public access during the nesting period (April 1 through August 12, 2005). Because no plovers were observed for several weeks within the vicinity of Parking Lots 6 & 7, this area was re-opened on July 6. The area just off Lot #1 (from the foot of the stairway to the north boundary) remained open during the entire nesting period for public access. This area was symbolically fenced and signed.

Habitat Response
Not applicable.

Response of Resources of Concern
The total of 7 piping plover pairs were documented on the Refuge in 2005 with a total of 13 nesting attempts. Six of the 7 pairs hatched 23 chicks and fledged 13 young. The resulting productivity was 1.86 chicks per breeding pair. Of the 6 pairs which hatched eggs, 5 pairs hatched 4 eggs, and 1 pair hatched 3 eggs. Including failed nests, a total of 42 eggs were laid of which 23 hatched, a 54.8 % hatching success. All 6 pairs which hatched eggs fledged young. Two pairs fledged 3 young each, 3 pairs fledged 2 young each and 1 pair fledged 1 young. Therefore, a total of 13 chicks fledged from 23 hatchlings resulted in a 56.5% fledgling success.

Proposal Year: Management Strategy Prescriptions
Refuge plans are to continue with the monitoring, and protective efforts described under the objectives section.

H. Artificial Nesting Structure Management

Habitat Objectives
The Refuge maintains artificial nesting structures for two species, purple martin and ospreys, that have largely lost their natural breeding habitat. Purple martin colonies are located at four sites throughout the Refuge: at the old Refuge HQ located on the north end of Plum Island, the new HQ site, the visitor contact station near lot #1, and at maintenance facilities halfway down the Refuge. Osprey platforms are located at three sites throughout the Refuge: the end of the Pines Trail road in the salt marsh, on the south side of Cross Farm hill and at Nelson's Island.

2005 Management Prescription
The purple martin boxes were installed at the end of the April. Volunteers monitored and maintained the boxes throughout the breeding season. The boxes were checked on a biweekly schedule. Eggs, chicks, and adults were recorded, and non-native invasive species (e.g. house sparrow, European starling) were ejected if found nesting in the boxes. There was no formal monitoring for the nesting ospreys; although the two located at Pines Trails and Cross Farm were monitored incidentally by staff while conducting other duties.

Habitat Response
Not applicable.

Response of Resources of Concern
The Purple Martins nested successfully at the Old Headquarters and Lot 1 locations. The Refuge had a total of 38 nests and 50 fledglings. Although the productivity was low this year compared to previous years, the Refuge colony made up roughly 50% of all recorded fledglings in the State. The weather played a big role in the reduced numbers this season. A big Nor'easter hit the refuge in late May challenged the adults, and continuous rainy days in July made insects unavailable during a critical time of chick development.

	2005	**2004**
No. PUMA nests	38	52
Total # PUMA eggs laid	179	517
Peak # PUMA chicks	101	374
No. PUMA fledge	50	61
Hatching success	56%	72%
Fledgling Success	50%	16%
No. Sparrow Nests removed	159	134

No. Sparrow eggs removed	108	162

No ospreys nested in the Cross Farm platform. The pair using the Pines Trail platform fledged two young. A pair was observed using the Nelson Island platform, and did lay eggs, although no fledgling data is known.

Proposal Year: Management Strategy Prescriptions
Retrofit the purple martin nesting boxes to increase occupancy and safety. Continue to monitor and maintain the boxes using volunteers. Recruit volunteer to monitor productivity of nesting ospreys.

I. Baseline Inventory

Historically, management and surveys at Parker River have focused primarily on birds. As we move to an ecosystem approach for management, the Refuge has a goal of insuring biological integrity of the various natural communities of Plum Island. The following objectives involve gathering baseline data in order to make better-informed decision in the future.

Habitat Objectives
- Inventory the Refuge for the less-known taxas, such as plants, insects, and amphibians.
- Prevent loss or degradation of rare vegetative communities through routine monitoring efforts.

Habitat Response
Not applicable.

Management Strategy Prescription for 2005 and Response of Resources of Concern
The Refuge initiated a plant inventory and associated herbarium in 2004 to better document the plant species found in the Refuge's diverse habitats. In 2005, we initiated an insect collection to inventory and document insect species found on the Refuge. The herbarium and insect collection will be used as a reference for Refuge and seasonal staff to ensure accurate identification for various wildlife surveys. To date, 107 plant species and over 60 insect species have been identified and cataloged.

Staff surveyed for two rare plants known to occur on the Refuge. We successfully found numerous population of seaside three-awned needlegrass (*Aristida tuberculosa*), which are thriving on the Refuge. We have search three consecutive years for dragon's mouth (*Arethusa bulbosa*), and have not been able to locate a population. The last sighting was from 1974.

Proposal Year: Management Strategy Prescriptions
We will continue with the plant and insect inventory in 2006, concentrating on a complete inventory of woody plants, and plants found in the impoundment and salt marsh habitats. We will continue to search for *Arethusa bulbosa* as time and funding allows.

Appendix A. Frequency occurrence and percent abundance of plant species found in the Bill Forward Pool in 2004.

Species	2002		2003		2004		2005	
	Freq.	Abun.	Freq.	Abun.	Freq.	Abun.	Freq.	Abun.
Aster subulatus	.033	.08	0.30	26.72	0.10	1.43		
Atriplex patula	.167	2.43	0.33	6.05	0.07	0.17	0.07	0.17
Bidens connata	.067	.17	0.13	2.50	0.33	4.10	0.07	1.80
Eleocharis parvula	.033	.52	0.03	15.50	0.23	19.30	0.33	29.13
Erechtites hieracifolia	.167	.85	0.33	12.20	0.33	1.73	0.10	1.60
Lythrum salicaria	.667	10.98	0.83	28.16	0.70	34.00	0.43	5.63
Panicum virgatum	.567	39.7	0.23	23.51	0.07	2.18		
Phragmites	.333	3.32	0.37	14	0.50	16.63	0.33	11.05
Pluchea odorata	.133	.33	0.20	12.75	0.27	1.12	0.07	0.17
Scirpus americanus/pungens	.233	6.18	0.10	11.17	0.30	6.38	0.10	1.88
Scirpus maritimus	.167	.42			0.17	4.80	0.03	0.53
Typha latifolia	.167	5.58	0.27	38.50	0.17	9.63	0.17	6.12
Bare Ground	-	-	0.17	24.50	-	-	0.37	16.27
Water	-	-	-	-	0.27	24.13	0.17	13.60
Achillea millefolium			0.07	20.25	0.07	0.17		
Agalinis maritima					0.03	0.08		
Agrostis stolonifera					0.67	13.48	0.50	30.00
Aster novi-belgii			0.10	6.83				
Aster sp.					0.07	0.62		
Calystegia sepium					0.20	1.85	0.17	2.43
Carex straminea							0.13	1.23
Cuscuta sp.					0.07	0.17		
Cyperus filicinus	.033	.08						
Cyperus strigosus							0.03	0.53
Gallium tinctorium					0.07	0.62		
Hordeum jubatum							0.07	1.80
Iris versicolor	.033	.08						
Juncus canadensis							0.03	0.08
Juncus effusus							0.07	0.62
Lycopus americanus							0.03	0.08
Onoclea sensibilis			0.03	2.50				
Panicum dichotoflorum							0.10	1.88
Parthenocissus quinquefolia					0.03	0.53		
Polygonum spp.	.033	2.85			0.13	0.33		
Puccinellia fasciculate	.33	10.55						
Rumex maritima					0.03	0.08		
Rumex orbiculatus							0.10	0.70
Salix serissima	.033	1.27						
Scirpus validus					0.03	0.08		
Solanus sarrachoides	.033	.08						
Solidago sempervirens							0.07	0.17
Thelypteris thelpteroides			0.03	2.50				
Toxicodendron radicans					0.03	2.87		

Frequency occurrence and percent abundance of plant species found in the moist-soil area of Stage Island Pool.

Species	2003		2004		2005	
	Freq	Abun	Freq	Abun	Freq	Abun
Agrostis stolonifera			0.03	0.08	0.03	2.10
Atriplex patula	0.07	0.17	0.10	0.25		
Bidens connata			0.03	2.10	0.13	1.23
Eleocharis parvula	0.07	2.62			0.23	8.62
Erechitites hieracifolia	0.27	7.02	0.07	0.62	0.10	1.15
Lythrum salicaria	0.47	7.72	0.10	1.15	0.20	2.58
Scirpus maritimus	0.13	10.65	0.13	1.23	0.10	0.70
Scirpus pungens/americanus					0.17	1.77
Phragmites australis	0.27	7.93	0.27	16.25	0.13	1.52
P. australis (dead)					0.17	4.05
Typha sp.	0.60	24.23	0.47	32.32	0.20	17.63
Bare Ground	0.70	21.33	0.17	16.33	0.57	35.73
Water			0.03	3.27	0.10	9.80
Agalinis maritima					0.03	0.08
Agrostis gigantea					0.03	1.27
Carex sp.			0.03	2.10		
Chenopodium rubrum					0.03	0.08
Cyperus esculentus						
Cyperus filicinus	0.07	0.17			0.13	6.72
Cyperus strigosus					0.03	0.08
Galium tinctorium			0.03	0.53		
Juncus sp.			0.03	0.08		
Panicum dichotoflorum					0.17	10.87
Panicum sp.					0.10	2.33
Panicum virgatum	0.23	3.07				
Spartina alterniflora	0.07	0.17				
Spartina pectinada					0.03	3.27
Spergularia maritima					0.07	0.62

Frequency occurrence and percent abundance of plant species found in the robust veg area of Stage Island Pool.

Species	2003		2004		2005	
	Freq	Abun	Freq	Abun	Freq	Abun
Agrostis stolonifera			0.08	1.00	0.06	4.74
Atriplex patula	0.06	1.27	0.01	0.02	0.01	0.32
Bidens connata			0.05	1.52	0.08	1.27
Eleocharis parvula	0.03	0.08			0.02	0.27
Erechitites hieracifolia	0.31	6.41	0.05	0.12	0.13	3.67
Lythrum salicaria	0.13	1.83	0.13	3.97	0.15	3.40
Scirpus maritimus					0.15	3.92
Scirpus pungens/americanus			0.06	0.73	0.03	0.89
Phragmites australis	0.50	10.69	0.44	13.76	0.54	30.41
Typha sp.	0.47	6.23	0.36	8.39	0.18	8.91
Bare Ground	0.88	60.77	0.30	21.45	0.33	15.80
Water			0.11	8.55		
Agrostis gigantea					0.05	1.86
Calystegia sepium			0.03	0.20	0.01	0.32
Chenopodium rubrum					0.01	0.03
Cyperus esculentus					0.01	0.14
Cyperus filicinus					0.02	0.46
Echinochloa sp.			0.02	0.18		
Frangula alnus					0.02	0.05
Galium tinctorium			0.06	0.62	0.03	0.70
Hypericum mutilum					0.03	0.49
Impatiens capensis					0.01	0.14
Juncus canadensis					0.02	0.46
Juncus sp.			0.02	0.18		
Mikania scandens	0.03	0.08				
Panicum dichotoflorum					0.50	34.35
Panicum sp.					0.16	6.20
Panicum virgatum	0.03	1.19	0.01	0.02		
Parthenocissus quinquefolia					0.01	0.03
Polygonum sp.			0.01	0.02	0.06	0.92
Rumex maritimus			0.04	0.36	0.07	1.65
Spartina alterniflora	0.03	0.48				
Spartina pectinada			0.04	1.48	0.04	2.87
Toxicodendron radicans			0.01	0.15		